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Forest Pest Management Report

R-3 84-6

BIOLOGICAL EVALUATION
Spruce Beetle

Elk Mountain
Las Vegas and Pecos Ranger Districts
Santa Fe National Forest
New Mexico

January 1984

3430

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USDA Forest Service, Southwestern Region
State and Private Forestry
Forest Pest Management
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ABSTRACT

A spruce beetle outbreak, within a portion of the proposed Wesner timber sale, Santa Fe National Forest, was evaluated to determine how it might affect cutting strategies during the sale. A systematic sample was conducted by Forest Pest Management personnel within a 200-acre area of concentrated spruce mortality. Survey results estimated 4.9 trees per acre attacked in 1983 and 9.1 trees per acre attacked in 1982. Many small root disease centers containing shoestring and annosus root diseases were observed throughout the survey area and are providing a constant source of blown-down trees in which the beetle population can continue to build.

Cutting strategies and recommendations to utilize current spruce mortality, reduce stand susceptibility to future spruce beetle outbreaks, and minimize the effects of root diseases are discussed in this report.

INTRODUCTION

At the request of Jim Montoya, Las Vegas District Ranger, personnel from Forest Pest Management (FPM) conducted a biological evaluation on a portion of the Wesner timber sale, south of Elk Mountain (figure 1). The purpose of the survey was to estimate the intensity, extent, and trend of a localized spruce beetle, Dendroctonus rufipennis (Kirby), infestation, and determine what influence the infestation might have on the planned Wesner timber sale.

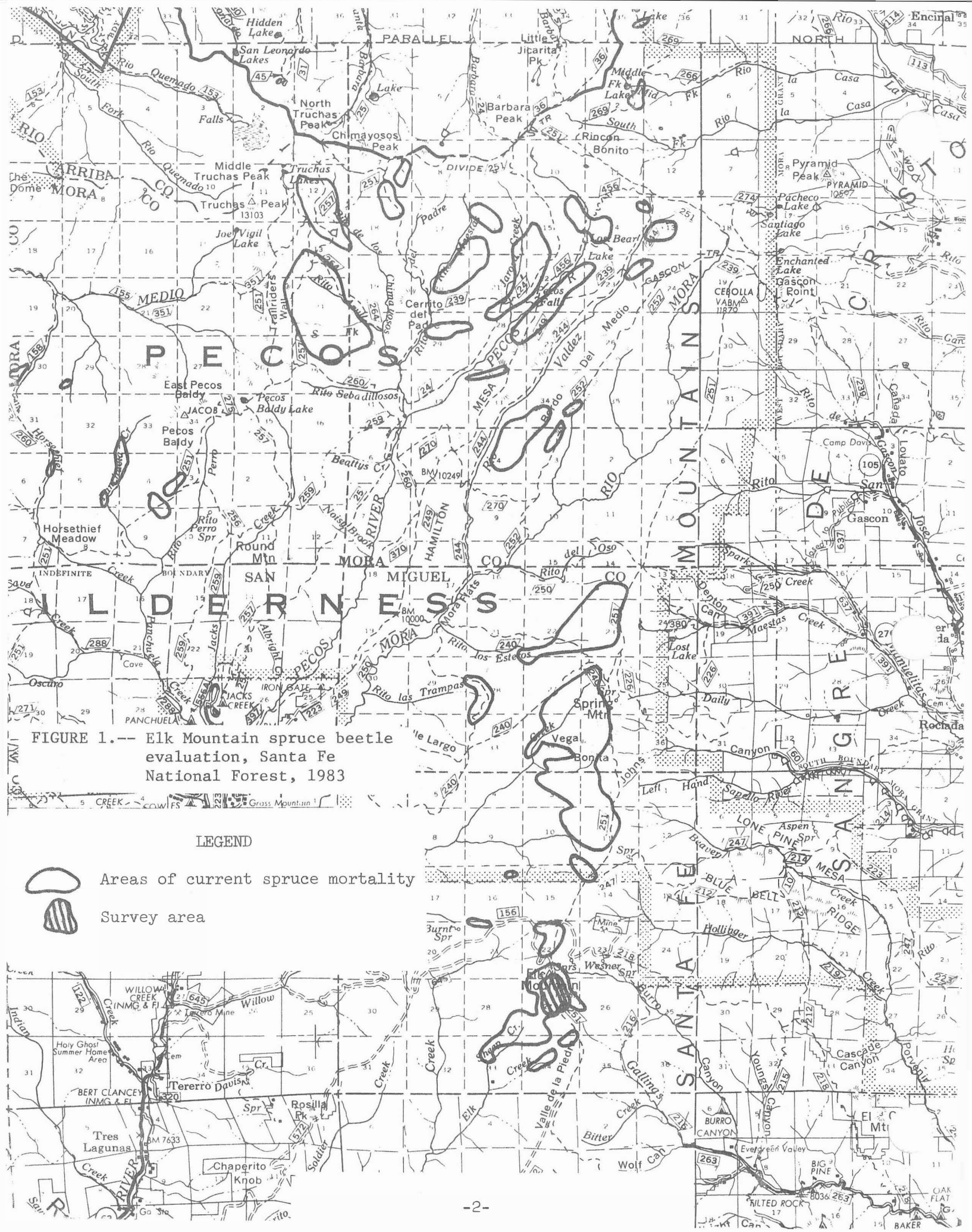
TECHNICAL INFORMATION

Pests. Spruce beetle, Dendroctonus rufipennis (Kirby)
Shoestring root disease, Armillariella mellea
Annosus root disease, Heterobasidion annosum (Fomes annosus)

Host. Engelmann spruce, Picea engelmannii Parry

Biology of Spruce Beetle. The spruce beetle generally has a 2-year life cycle, although 1- and 3-year life cycles have been described. Normally this beetle is present in small numbers in weakened or windthrown trees, large pieces of slash, and fresh stumps (Furniss and Carolin 1977). Outbreaks often develop following a major forest disturbance (i.e., windthrow or logging debris) which creates an abundance of suitable breeding material. Beetle populations rapidly build up in the down material, then spread to standing trees. Outbreaks may persist until suitable host material is depleted (Linnane 1983).

Adult spruce beetles attack their hosts and lay eggs during May, June, and possibly early July. Eggs hatch and larvae develop during the summer. These immature larvae overwinter, then resume feeding in the spring. Larvae pupate and transform into adults by late summer-early fall. Adults overwinter, then emerge in the spring to attack new host material.


PECOS
WILDERNESS
SANTA FE
SAN MIGUEL
MORA
RIO ARRIBA
CO
INDEFINITE BOUNDARY
PARALLEL
NORTH
Hidden Lake
San Leonardo Lakes
North Truchas Peak
Chimayosos Peak
Middle Truchas Peak
Truchas Peak 13103
Joe Vigil Lake
Barbara Peak
Little Jicarita Pk
Rincon Bonito
Middle Fk Lake
South Fk Rio la Casa
Pyramid Peak
PYRAMID 10507
Pacheco Lake
Santiago Lake
Enchanted Lake
Gascon Point
CEBOLLA VABM 11870
Lost Bear Lake
Cerrito del Padre
East Pecos Baldy
Pecos Baldy Lake
Pecos Baldy
JACOB
Rito Sebadillosos
Beatys Cr
Horsethief Meadow
Round Mtn
Rito Perro Spr
Noisy Brook
HAMILTON MESA
Mora Flats
Rito los Esteros
Rito las Trampas
Lost Lake
Daily
Sprin Mtn
Vegal Bonita
Left Hand
Sapello River
Aspen Spr
LONE PINE MESA
BLUE RIDGE
Hollinger
Burnt Spr
Wasner Spr
Elk Mountain
Gascon
Maestas Creek
Deion Cany
Sparks Creek
Rito del Oso
Rito Valdez
Del Medio
Rito de la Cañada
Camp Davis
Lovato
Rociada
Canyon
Cascade Canyon
Youngs Canyon
BURRO CANYON
Evergreen Valley
BIG PINE
TILTED ROCK
OAK FLAT
BAKER
Tererro Davis
Rosilla Pk
Tres Lagunas
Chaperito Knob
WILLOW CREEK (INMG & FI)
BERT CLANCEY (INMG & FI)
Holy Ghost Summer Home Area
Valle de la Piedra
Wolf Can
Bitter Creek
Gallinas River
Indian Creek
Willow Creek
Elk Creek
Burro Cr
Chaco Cr
Rito Quemado
South Fork Rio Quemado
Rio Quemado
Barbara Creek
Jarosa Creek
Trailriders Walk
Rito de los Chimayosos
Rito del Padre
Rito Valdez
Rito Medio
Rito Perro
Rito Horsethief Cr
Rito Beatys Cr
Rito Noisy Brook
Rito Hamilton
Rito los Esteros
Rito las Trampas
Rito Sebadillosos
Rito Jacks Creek
Rito Albright Cr
Rito Panchuela
Rito Oscuro
Rito Cave
Rito Jacks
Rito Perro Spr
Rito Pecos
Rito Mora
Rito Gascon
Rito Lovato
Rito Cañada
Rito Sparks
Rito Deion Cany
Rito Maestas Creek
Rito Daily
Rito Rociada
Rito Johns Creek
Rito Beaver Creek
Rito Ridge
Rito Hollinger
Rito Burro Creek
Rito Youngs Canyon
Rito Cascade Canyon
Rito Porvenir
Rito Gallinas
Rito Elk Creek
Rito Chaco Cr
Rito Indian Creek
Rito Willow Creek
Rito Bitter Creek
Rito Wolf Can
Rito Valle de la Piedra
Rito Soldier
Rito Chaperito
Rito Tres Lagunas
Rito Rosilla Pk
Rito Tererro Davis
Rito Holy Ghost Summer Home Area
Rito Bert Clancey (INMG & FI)
Rito Willow Creek (INMG & FI)
Rito Tererro Mine
Rito Burnt Spr
Rito Wasner Spr
Rito Hollinger
Rito Ridge
Rito Aspen Spr
Rito Lone Pine Mesa
Rito Blue Ridge
Rito Left Hand
Rito Sapello River
Rito Vegal Bonita
Rito Sprin Mtn
Rito Daily
Rito Lost Lake
Rito Maestas Creek
Rito Deion Cany
Rito Sparks Creek
Rito del Oso
Rito Valdez
Rito Medio
Rito de la Cañada
Rito Camp Davis
Rito Lovato
Rito Rociada
Rito Canyon
Rito Cascade Canyon
Rito Youngs Canyon
Rito Burro Canyon
Rito Evergreen Valley
Rito Big Pine
Rito Tilted Rock
Rito Oak Flat
Rito Baker
Rito Gascon
Rito Enchanted Lake
Rito Lost Bear Lake
Rito Cerrito del Padre
Rito East Pecos Baldy
Rito Pecos Baldy Lake
Rito Pecos Baldy
Rito Jacob
Rito Rincon Bonito
Rito Middle Fk Lake
Rito South Fk Rio la Casa
Rito Pyramid Peak
Rito Pacheco Lake
Rito Santiago Lake
Rito Cebolla VABM 11870
Rito Gascon Point

Biology of Shoestring Root Disease (Bega 1978, Wood 1983). Armillariella mellea is the fungus responsible for the root disease known as shoestring root disease of conifer and orchard trees. It is both a common forest pathogen and saprophyte in temperate and tropical regions in the Northern Hemisphere. It affects a wide range of hardwoods and conifers, including all commercial tree species in the Southwestern Region. The fungus typically invades roots and root collars of stumps or dead trees by means of airborne spores, then utilizes the invaded substrate to develop inoculum potention.

A. mellea is spread to living trees through root contacts with old infected roots or stumps, or by rhizomorphs, slender stringlike strands of fungal material resistant to unfavorable environmental factors and antagonistic agents, which grow through the upper soil and litter layers. When these rhizomorphs contact the root or root crown of a new host, they penetrate through the bark and attempt to establish an infection.

Trees rapidly killed by this fungus include all seedlings and saplings; older, unthrifty trees; and trees of any size or vigor in close proximity to an inoculum source. Vigorous pole-sawtimber-sized trees which become infected may survive for indefinite periods of time, although with reduced growth rates. However, this weakened condition often predisposes the tree to attack by bark beetles.

Biology of Annosus Root Disease (Bega 1978, Wood 1983). Heterobasidion annosum (Fomes annosus), the cause of annosus root disease, is worldwide in distribution and infects a large number of conifer species in the Western United States. It is spread by means of airborne spores which land on a fresh stump surface, germinate, and colonize root collars and roots. Nearby live trees are infected by means of root contacts and grafts. The fungus then spreads through the roots of the new host to the root crown. The rest of the tree's root system is colonized and the fungus spreads to neighboring trees, again by root contact. Thus, enlarging infection centers are formed. Typical centers contain fading trees or trees with thin and chlorotic crowns, as well as trees which have died over a period of years.

History of Spruce Beetle on the Las Vegas and Pecos Ranger Districts (Lessard 1976). The first recorded infestation of spruce beetle on the Pecos and Las Vegas Ranger Districts occurred in Gallinas Canyon during the mid-1930's. This infestation was either "controlled" by Emergency Relief Authority crews (details of the control implemented are not known) or subsided due to natural factors. Two short-lived infestations occurred, one in Alamitos Canyon from 1946 to 1947 and the other in the Rio Mora drainage from 1960 to 1961, each of which declined of natural causes. In 1962, a 500-acre infestation developed on the north, west, and southwest sides of Elk Mountain. The decline of this infestation by 1963 was attributed to heavy predation by woodpeckers. Spruce beetle populations remained low until 1982 when a large outbreak was detected throughout much of the Pecos Wilderness and south to Elk Mountain. This outbreak continued in 1983, with spruce mortality detected over approximately 8,000 acres, including about 375 acres on and around Elk Mountain.

METHODS

Approximately 200 acres of concentrated spruce mortality were delineated within the bounds of the Wesner timber sale from FPM's 1983 insect and disease aerial detection sketch maps and visual ground reconnaissance. This area was then systematically sampled to obtain data on stand composition and structure, incidence, cause, extent, and year of mortality. Twenty-six variable (BAF 30) plots were established on a 5- by 5-chain spacing. Trees within the plots were recorded to the following designations: Green (unattacked), current (1983) attack, previous year's attack (faded following 1982 attack), older dead (all beetle-killed trees older than 2 years), strip attack, unsuccessful attack (pitchout), or other mortality. Diseases and other damaging agents were also noted when present. All species were tallied by diameter. Twenty-five percent of all trees within each plot, over 5 inches in diameter at breast height (d.b.h.), were measured for height. Regeneration (trees under 5 inches d.b.h.) was not sampled. Data were analyzed using the computer program "INDIDS R03" (Bennett et al. 1983).

RESULTS AND DISCUSSION

Table 1 shows results of the data analysis which indicate the spruce beetle population is high within the area surveyed. This is evidenced by the frequency of 1983 and 1982 attacks: 4.9 trees per acre attacked in 1983, representing 231.5 cubic feet per acre, and 9.1 trees per acre attacked in 1982, representing 405.2 cubic feet per acre. This occurrence of numerous attacks in both 1982 and 1983 may be due to either overlapping 2-year life cycle populations or that a large portion of the population is taking 3 years to complete development. Trees killed by spruce beetle prior to 1982 numbered 19.9 per acre, representing 705.6 cubic feet per acre. Total number of spruce beetle-killed trees was 33.9 per acre, representing 1,341.8 cubic feet per acre. Other accumulative standing spruce mortality, caused by unknown factors, accounted for an additional 6.2 trees per acre, representing 148.1 cubic feet per acre.

The area surveyed was in a continuous single-storied Engelmann spruce stand. The average basal area was 252 square feet per acre, with an average diameter of 12.6 inches in all trees over 5 inches d.b.h., and 15.3 inches in all live trees over 10 inches d.b.h. Site index varied from 70 to over 100. Corkbark fir was present, but constituted less than 2 percent of the trees per acre.

Root diseases were not found at any of the plots sampled; however, many small root disease centers containing A. mellea and H. annosum were observed throughout the area. Root-rotted, blown-down trees, within and along the edges of the centers, are providing a constant source of preferred beetle host material and will continue to be a contributing factor in perpetuating the current beetle population and subsequent mortality (Wygant and Lejeune 1967).

BARK BE[illegible] SURVEY 20/83

--SPECIES TOTAL--

SANTA FE ELK MTN 10

DIAMETER CLASS		UNDAM. STAND	CUR. ATTACK	LAST YEAR'S ATTACK	OLDER ATTACK	UNSUC. ATTACK	CUR. STRIP ATTACK	OLDER STRIP ATTACK	CUR. SEC. ATTACK	OLDER SEC. ATTACK	OTHER I+D PROB.	OTHER DAM. AGENTS	OTHER MORT.	STAND TOTAL
0- 4.9	TA	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
	BA	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
5- 8.9	TA	76.[illegible]	.0	.0	5.5	.0	.0	.0	.0	.0	.0	.0	3.1	85.6
	BA	15.5	.0	.0	1.2	.0	.0	.0	.0	.0	.0	.0	1.2	20.8
	CFA	302.4	.0	.0	17.4	.0	.0	.0	.0	.0	.0	.0	16.8	336.5
	BFA	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
9-11.9	TA	69.2	.0	1.3	.0	5.3	2.3	.0	.0	2.0	.0	.0	.0	80.7
	BA	41.5	.0	1.2	.0	3.5	1.2	.0	.0	1.2	.0	.0	.0	48.5
	CFA	925.4	0	25.3	.0	78.0	23.9	.0	.0	24.8	.0	.0	.0	1077.4
	BFA	2764.1	.0	74.7	.0	253.3	56.6	.0	.0	69.3	.0	.0	.0	3218.0
12 +	TA	78.4	4.9	7.2	14.4	13.1	.9	3.0	.0	.6	.0	.0	3.0	123.6
	BA	100.4	8.1	12.7	24.2	21.[illegible]	3.5	6.[illegible]	.0	1.2	.0	.0	4.6	182.3
	CFA	2764.0	231.5	379.[illegible]	698.3	615.[illegible]	110.[illegible]	221.[illegible]	.0	34.2	.0	.0	131.3	5182.7
	BFA	11834.8	1027.9	1718.3	3072.7	2737.3	526.9	1032.[illegible]	.0	155.6	.0	.0	581.1	22649.4
TOTALS	TA	223.5	4.9	9.1	19.[illegible]	18.4	3.2	3.0	.0	2.6	.0	.0	6.2	289.8
	BA	160.4	8.1	13.8	25.4	24.2	4.6	6.[illegible]	.0	2.3	.0	.0	5.6	251.5
	CFA	3596.8	231.5	405.2	735.6	693.[illegible]	134.6	221.[illegible]	.0	59.0	.0	.0	148.1	6596.6
	BFA	14599.[illegible]	1027.9	1793.[illegible]	3072.7	2991.5	585.5	1032.[illegible]	.0	224.8	.0	.0	581.1	25907.4
PERCENT STANDARD ERROR														
TOTALS	TA	14.1	34.9	44.7	34.0	24.1	71.9	43.7	.0	79.7	.0	.0	55.8	11.7
	BA	11.0	33.0	40.3	27.6	17.4	46.9	43.7	.0	69.3	.0	.0	41.0	7.3
	CFA	11.4	33.2	40.9	28.3	17.0	47.8	45.4	.0	70.2	.0	.0	42.6	7.1
	BFA	13.1	33.5	40.1	29.1	17.8	50.5	46.0	.0	74.6	.0	.0	43.2	7.6

TA = Trees per acre
BA = Basal area
CFA = Cubic feet volume per acre
BFA = Board feet volume per acre

TABLE 1.--Stand composition, Elk Mountain spruce beetle survey, 1983

Results of this survey also show susceptibility to further spruce beetle caused losses remains moderate to high. Susceptibility can be determined on the basis of four stand characteristics: Physiographic location, using Alexander's (1967) site indexes; average diameter of spruce; basal area; and percentage of spruce in the canopy (Schmid and Frye 1976). Table 2 compares risk (susceptibility) categories for each of the four stand characteristics.

TABLE 2.--Risk categories for potential spruce beetle outbreaks for each stand characteristic (Schmid and Frye 1976)

Risk category[1]	Physiographic location	Average diameter of live spruce above 10 inches d.b.h.	Basal area	Proportion of spruce in canopy
		Inches d.b.h.	Ft^2	Percent
High (3)	Spruce on well-drained sites in creek bottoms	>16	>150	>65
Medium (2)	Spruce on sites with site index of 80 to 120	12-16	100-150	50-65
Low (1)	Spruce on sites with site index of 40 to 80	<12	<100	<50

[1] Number in parentheses indicates arbitrary value to be used in calculating stand priority, and is used only for convenience.

Once stand characteristics have been determined, they are compared to risk categories in the preceding table and classified as to high (3), medium (2), or low (1). Numeric values for each of the four stand characteristics are then added together. The total becomes the stand risk value which is used to classify the stand as having a high, medium, or low outbreak potential:

Stand risk value	Potential outbreak rating
11-12	High
7-9	Medium
4-5	Low

The susceptibility value of the area surveyed in this evaluation was determined using the following stand characteristics: (1) Average site index of 80+, (2) average d.b.h. of the live spruce over 10 inches d.b.h. of 15.3 inches, (3) basal area of 252 square feet per acre, and (4) 98 percent of the canopy is spruce. Comparing these characteristics to the risk ratings in table 2, values of 2, 2, 3, and 3 are obtained. Added together, these values give a stand risk value of 10, which is translated into a potential outbreak rating or susceptibility of remaining stand between medium and high.

Based on (1) the rate of recent mortality, (2) the high population of spruce beetles in currently infested trees, (3) the presence of fresh blowdown and broken tops in and around numerous root disease centers, and (4) the moderate to high susceptibility of the remaining green stand, we predict mortality rates will continue for the next few years at current levels throughout the survey area. Mortality will occur in the larger trees first. The rate and extent of spread into adjacent spruce-fir type will vary according to stand susceptibility.

MANAGEMENT ALTERNATIVES

The following alternatives are offered for management of spruce beetle in the Wesner timber sale.

1. Direct Suppression. Under this alternative, direct action is taken to suppress the infestation by treating individual infested trees either with an insecticide or by felling and burning or felling and debarking. To be effective, a high percentage (>90 percent) of the infested trees must be located and treated. In most situations, this is a difficult to nearly impossible task, with very high costs for presuppression surveys and treatment, and will, at best, only slow the infestation. Another consideration with this alternative is that felling of many infested trees may adversely affect the windfirmness of the residual stand. In addition, this alternative will have very little effect on reducing susceptibility to root diseases. Therefore, future attractive breeding sites for spruce beetles will be numerous.

2. Trap Trees. This alternative involves felling uninfested live merchantable spruce prior to beetle flight. As these felled trees are more attractive to spruce beetles, they serve to attract them away from live standing trees. To be effective, trap trees must be felled in accessible areas and removed or treated prior to the next beetle flight. Unfortunately, we do not know the number of trap trees required for adequate control or where they should be felled. A variation of trap trees is lethal trap trees, where, prior to felling, trees are injected with silvicides. When the tree is attacked after felling, the silvicides kill the brood (Schmid and Frye 1977).

If properly planned and administered, trap-tree or lethal trap-tree methods may be effective on infestations of limited size; however, we feel that the present spruce beetle population in the area and the susceptibility rating of the remaining green stand are too high for this strategy to be effective. Susceptibility to root diseases will not be reduced by this method.

3. Silvicultural Strategies. Silvicultural strategies can be employed to reduce stand susceptibility to spruce beetle infestations by reducing basal area through removal and utilization of susceptible, infested, and dead trees. Such strategies will also reduce susceptibility to root diseases by reducing stocking levels, thereby increasing tree vigor and reducing the size and amount of material available for occupation by the fungus (Wood 1983). These strategies include

both intermediate and regeneration cuts. The percentage of attacked and/or susceptible spruce within the stand and the risk of windfall after cutting may influence which of these strategies is most appropriate.

a. Intermediate Cuts. Intermediate cuts, such as sanitation and salvage, can be carried out to maximize utilization of weakened, infested, and dead trees while reducing stand susceptibility. However, such cuts may result in removal of a high percentage of basal area and are therefore a calculated gamble in above average wind-risk situations.

Salvage cuts remove dead or infested trees with the intent to maximize utilization. This method may slow the spruce beetle infestation by removing some of the brood, but it will not suppress or appreciably change the course of the infestation, nor will it affect the occurrence or spread of root disease.

Sanitation cuts involve felling and removing susceptible (large diameter), as well as infested and dead trees. The intent is to also maximize utilization while reducing the stand susceptibility. By reducing the stocking level, this method will also reduce susceptibility to root diseases. However, removal of all susceptible, infested, and dead trees within the area surveyed would reduce the basal area 30 to 40 percent, leaving the stand an extremely high windfall risk.

b. Regeneration Cuts. Two types of regeneration cuts, shelterwood and clearcut, are suggested cutting methods in spruce-fir types of the Southwest (FSM R-3 Supp. 226, 12/82), and, under certain conditions, may be viable alternatives for managing spruce beetle and root diseases.

Use of the shelterwood method as a strategy for reducing stand susceptibility to spruce beetle or root disease has the advantage of treating larger areas than the maximum specified for clearcuts. The preparatory cut of a shelterwood method is made in a dense stand of timber to permit development of vigorous seed bearers and, in some instances, to promote windfirmness. This method may reduce susceptibility to root diseases and spruce beetle by reducing the stocking level and increasing stand vigor; however, it will not suppress or significantly alter the course of any current infestations.

Clearcutting may be the only available option where windfall risks are very high. In this method, all of the merchantable volume in the cut areas will be utilized. Although the infestation will continue in the uncut areas, resulting in additional mortality, the windfall risk should remain low and much of the volume can be utilized during later cuts. Cleared openings should not be larger than regeneration requirements dictate, and they should be interspersed with uncut areas of at least equal size (Alexander 1974). Not more than one-third of the total area should be cut over at one time. Once regeneration has become established in the cut areas, an additional

one-third of the total area can be cut, and so forth. Although root disease inoculum will remain in stumps within the clearcut areas and will cause some mortality as regeneration becomes established in and around existing root disease centers, this method will allow for proper management to optimize growth and vigor of individual trees by early thinning to low stocking levels.

RECOMMENDATION

Within the area we surveyed and in adjacent stands with current spruce beetle activity and/or a high susceptibility to infestation, we recommend the clearcut alternative, using either patch or strip clearcuts. Initial cuts should be made in areas of concentrated spruce beetle attacks and mortality. At the same time, salvage and/or sanitation cuts may be conducted in the leave areas to utilize dead and infested trees and reduce susceptibility of the remaining stand. Most of the merchantable volume will be utilized and the next stand can be managed to maintain optimum growing stock levels which should minimize future outbreaks of spruce beetle and losses caused by root diseases.

For the remainder of the spruce-fir type within the proposed Wesner timber sale, we recommend timber stand examination information be used to rate each stand for susceptibility to spruce beetle infestation. Once this has been accomplished, appropriate cutting methods can be developed for specific stands.

To minimize losses, we recommend that cutting begin as soon as possible in infested and highly susceptible spruce-fir stands. Guidelines for handling logging residuals are available (Schmid 1977) and should be followed to minimize additional buildup of spruce beetle populations. Stump height should be kept below 1.5 feet. Cull logs and tops should be limbed and bucked into short lengths and scattered in open areas. Log decks should be removed to millsites prior to beetle flight.

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